HEALTH CONSULTATION

EL PASO COUNTY METALS SURVEY

EL PASO, EL PASO COUNTY, TEXAS

July 11, 2002

Prepared By:

Texas Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

The Texas Department of Health (TDH) and the Agency for Toxic Substances and Disease Registry (ATSDR) were asked by the United States Environmental Protection Agency (EPA) to determine the public health significance of lead and arsenic found in surface soil samples from El Paso, Texas. Previously, TDH and ATSDR evaluated the public health significance of lead and arsenic found in surface soil samples from schools, parks, and other locations in El Paso [1-5].

DISCUSSION

Environmental sampling data, consisting of 318 surface soil samples obtained from 191 different locations, were collected by EPA=s contractor between February and March 2002 [6]. Areas sampled included residential yards, schools, parks, day-care facilities, apartment complexes, playground areas, community centers, and churches. At least one surface soil sample (0 to 1 inch in depth), composited from five-point aliquots of approximately equal volume, was collected from each sampling area. At some locations, two composite samples, were collected. For instance, at many residences two samples, one from the front yard and one from the back yard, were collected. At the time the samples were collected, estimates describing the extent of ground cover were made at 78 of the residential sampling locations. Qualitatively the ground cover was described as ranging from Ano cover@ to Agood grass@. Quantitatively, the ground cover was described as ranging from zero cover to 95% cover. Approximately 44% of the residential sampling locations described had less than 50% cover.

Soil lead concentrations ranged from 4 milligrams lead per kilogram-soil (mg/kg) to 1,600 mg/kg with an overall arithmetic average concentration of 197 mg/kg. Fifteen percent of the areas sampled had soil lead levels greater than 400 mg/kg. Eleven percent of the areas sampled had soil lead levels greater than or equal to 500 mg/kg (Figure 1). Sample results for lead by area type are presented in Table 1.

The concentration of arsenic in the soil ranged from 1 mg/kg to 490 mg/kg with an average concentration of 15 mg/kg. Twenty-three percent of the areas sampled had soil arsenic levels greater than or equal to 20 mg/kg. Thirteen percent of the areas sampled had soil arsenic levels greater than 30 mg/kg (Figure 2). Sample results for arsenic by area type are presented in Table 2.

Lead

To assess the potential health risks associated with the lead in the soil TDH used the Centers for Disease Control and Prevention=s (CDC=s) definition of excessive lead absorption in children and the estimated relationship between blood lead in children and soil lead concentrations (EPA=s integrated uptake biokinetic model) to derive a health-based assessment comparison (HAC) value for this contaminant. Although HAC values are guidelines that specify levels of chemicals in specific environmental media (soil, air, and water) that are considered safe for human contact, there is no clear dividing line between safe and unsafe exposures. Since many of the assumptions used to calculate HAC values are conservative with respect to protecting public health, exceeding a HAC value does not necessarily mean that adverse health effects will occur. However, exceeding a HAC value does suggest that potential site specific exposure to the contaminant warrants further consideration.

Based on observations of enzymatic abnormalities in the red blood cells at blood lead levels below 25 ìg/dL and observations of neurologic and cognitive dysfunction in children with blood lead levels from 10B15 ìg/dL, the CDC has determined that a blood lead level $10 ìg/dL in children indicates excessive lead absorption and constitutes the grounds for intervention [7]. The relationship between soil lead levels and blood lead levels is affected by factors such as the age of the population exposed to the contaminated soil, the physical availability of the contaminated soil, the bioavailability of the lead in the soil, and differences in individual behavioral patterns [8-10]. While there is no clear relationship applicable to all sites, a number of models have been developed to estimate the potential impact that soil lead could have on the blood lead levels in different populations [10-12]. In general, soil lead will have the greatest impact on the blood lead levels of preschool-age children. These children are more likely to play in dirt and to place their hands and other contaminated objects in their mouths. They are better at absorbing lead through the gastrointestinal tract than adults, and they are more likely to exhibit the types of nutritional deficiencies that facilitate the absorption of lead. For children, the predicted 95th percentile blood lead level associated with a soil lead concentration of 500 mg/kg is approximately 10 ìg/dL. This means that except in the most extreme cases (i.e., frequent contact by children exhibiting pica behavior, or desire for unnatural foods such as dirt or ashes) children regularly exposed to soil lead levels of 500 mg/kg should have no more than a 5% probability of having blood lead levels greater than 10 ìg/dL. Twenty-four residences, one daycare facility, and one apartment location had soil lead levels greater than or equal to 500 mg/kg.

Arsenic

To assess the potential health risks associated with the arsenic in soil TDH compared the soil concentrations to HAC values for non-cancer and cancer endpoints. The non-cancer HAC values for arsenic in soil (20 mg/kg for children and 200 mg/kg for adults) are based on EPA=s reference dose (RfD) for arsenic of 0.3 ìg/kg/day [13]. RfDs are based on the assumption that there is an identifiable exposure threshold (both for the individual and for populations) below which there are no observable adverse effects. Thus, the RfD is an estimate of a daily exposure to arsenic that is unlikely to cause adverse non-cancer health effects even if exposure were to occur for a lifetime. For arsenic, the RfD was derived by dividing the identified no observable adverse effects level (NOAEL[1]) of 0.8 ìg/kg/day, obtained from human epidemiologic studies, by an uncertainty factor of three. The lowest observable adverse effects level (LOAEL[2]) associated with these epidemiologic studies was 14 ìg/kg/day, where exposure to arsenic above this level resulted in hyperpigmentation of the skin, keratosis (patches of hardened skin), and possible vascular complications [13B15]. TDH used standard assumptions for body weight (70 kg adult and 15 kg child) and soil ingestion (100 mg per day for adults and 200 mg per day for a child) to calculate the HAC values. Forty-four residences, one daycare facility, three apartment locations, and one park had soil arsenic levels greater than or equal to 20 mg/kg, the non-cancer HAC value for small children.

[1] The highest dose at which adverse effects were not observed.

[2] The lowest dose at which adverse effects were observed.

Arsenic has been classified by the EPA, the International Agency for Research on Cancer (IARC), and the National Toxicology Program (NTP) as being a human carcinogen. The overall weight-of-evidence indicating that arsenic is a human carcinogen comes from human epidemiologic studies. An increase in lung cancer mortality was observed in multiple human populations exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer (non-malignant) were observed in populations consuming water high in inorganic arsenic [14]. The carcinogenic HAC value for arsenic of 0.5 mg/kg is based on EPA=s cancer slope factor (CSF) for skin cancer and an estimated excess lifetime cancer risk of one cancer in 1 million
(1×10^{-6}) people exposed for 70 years. Arsenic was detected in virtually all the soil samples at concentrations above its carcinogenic HAC value; however, the levels of arsenic normally found in the environment also exceed this HAC value [16]. Nonetheless, people who regularly ingest soil from some of these areas could have some theoretical excess lifetime risk for developing cancer. Qualitatively, depending on the specific exposure scenario, TDH estimates that the chronic ingestion of soil from these areas could result in an insignificant increased lifetime risk to a low increased lifetime risk for developing cancer.[3]

Public Health Significance of Lead and Arsenic in the Soil

The conclusions reached in this consultation pertaining to the public health significance of the lead and arsenic in the soil are based on data developed by EPA=s contractor. Although a description of the quality assurance and quality control (QA/QC) measures used to evaluate these data were not available for review, EPA Region 6 personnel indicated that the data were QA/QC=d to their satisfaction. TDH assumed the data to be accurate unless specifically qualified. TDH also assumed that the reported concentrations are representative to the contaminant concentrations to which people might be exposed.

Based on the goal of limiting the probability of exceeding a blood lead level of 10 µg/dL to no more than 5%, the concentrations of lead found in many of the residential yards and daycare facilities could be considered unacceptable. Additionally, children regularly exposed to soil from many of these residential yards, the daycare facility, and apartment location could be exposed to arsenic at levels high enough to exceed the NOAEL but not the LOAEL. Since by definition neither the NOAEL nor the LOAEL represent a sharp dividing line between Asafe@ and Aunsafe@ exposures, exposures greater than the NOAEL but less than the LOAEL could be considered to be unacceptable.

There are many mitigating factors that could affect the actual public health significance of the lead and arsenic found in the soil. For both contaminants, TDH assumed that the soil was available for ingestion and that physical barriers such as grass were not present. In reality, based on the yards for which this information was available, the presence of grass in the yards varied with approximately 44% of the yards being described as having less than 50% ground cover. Individual behavior patterns also are important in assessing exposure. The amount of soil that a person eats, how often they eat the soil, and

[3] Based on the assumption that a person would ingest 50 to 100 milligrams of soil per day, one to seven days per week, 50 weeks per year for 30 years.

the average concentration of the contaminant in the soil that they eat all are important factors in determining potential public health implications. For this consultation TDH assumed that people would eat soil from the yards every day and that their total daily consumption of soil and dust would come from the yards. In most instances these types of assumptions overestimate the potential exposures.

Acute Exposure (Pica Behavior)

Soil pica behavior (ingestion of more than 1.0 grams/day) may occur in a sizable portion of children throughout the year [17]. While any individual child may only exhibit pica behavior infrequently, the behavior is not limited to a small subset of the population. It has been estimated that approximately 62% of children will ingest >1.0 gram of soil on 1-2 days/year, while 42% and 33% of children will ingest > 5 and > 10 grams of soil on 1-2 days per year, respectively. For some contaminants periodic pica episodes potentially could result in acute intoxication [17]. To explore the potential public health significance of pica behavior at this site TDH estimated the concentration of arsenic in the soil that would need to be ingested on a short-term (acute) basis to exceed reported LOAEL values for serious effects (arsenic) in humans (Table 3). The effects associated with this acute LOAEL include facial edema and gastrointestinal symptoms (nausea, vomiting, diarrhea) [18]. TDH assumed that children of varying body weights (15kg to 35 kg) would ingest 5,000 mg of soil during a pica event. Based on these data, in some of the residential yards it is possible for a child who infrequently exhibited pica behavior to exceed the reported acute LOAELs for arsenic.

Uncertainties

There is considerable controversy with respect to assessing potential risks associated with exposure to arsenic. Both the RfD and the CSF are based on human ecological studies that have recognized uncertainties with respect to the assignation of exposure. Such studies find it difficult to avoid errors in assigning people to specific exposure groups. The studies upon which the RfD and the CSF are based also involved exposure to arsenic in drinking water. The ability of the body to absorb arsenic in water is likely higher than the ability of the body to absorb arsenic in soil. We assumed that the arsenic in the soil was 100% absorbed. Assuming that the applied dose (the amount available for absorption) is the same as the internal dose (the amount that has been absorbed), is conservative and to some unknown extent overestimates the risk. TDH also did not consider the kinetics of arsenic in the body in our risk estimates. The RfD and the CSF are based on daily exposures over a lifetime. Since the half-life (the time it takes **2** of the absorbed arsenic to be excreted) is short (40-60 hours), the risk estimates for exposures that occur less frequently than every day also may result in an overestimate of the risks.

With specific respect to the cancer risk estimates, the mechanisms through which arsenic causes cancer are not known; however, arsenic is not believed to act directly with DNA. Since the studies used to derive the CSF are based on exposure doses much higher than those likely to be encountered in these yards it is questionable whether it is appropriate to assume linearity for the dose-response assessment for arsenic at low doses. The actual dose-response curve at low doses may be sublinear which would mean that risk estimates based on the CSF overestimate the actual risks.

ATSDR's CHILD HEALTH INITIATIVE

TDH and ATSDR recognize that the unique vulnerabilities of children demand special attention. Windows of vulnerability (critical periods) exist during development, particularly during early gestation, but also throughout pregnancy, infancy, childhood and adolescence -- periods when toxicants may permanently impair or alter structure and function [19]. Unique childhood vulnerabilities may be present because, at birth, many organs and body systems (including the lungs and the immune, endocrine, reproductive, and nervous systems) have not achieved structural or functional maturity. These organ systems continue to develop throughout childhood and adolescence. Children may exhibit differences in absorption, metabolism, storage, and excretion of toxicants, resulting higher biologically-effective doses to target tissues. Depending on the affected media, they also may be more exposed than adults because of behavior patterns specific to children. In an effort to account for children's unique vulnerabilities, and in accordance with ATSDR's Child Health Initiative [20] and EPA's National Agenda to Protect Children's Health from Environmental Threats [21], TDH used the potential exposure of children as a guide in assessing the potential public health implications of the contaminants.

CONCLUSIONS

1. The concentrations of lead and arsenic in soil from many of the residential yards and one of the daycare facilities exceed their respective health-based screening values for children. Although some degree of grass cover may be present at some of these locations; thereby reducing the potential for exposure to the contaminants in some of these yards, these are areas that are likely to be frequented by pre-school age children. Based on available information TDH concludes that exposure to lead and arsenic at some of these areas could pose an unacceptable public health hazard to children.

2. For most of the areas where the health based screening values are exceeded, the health hazards, while present, do not pose immediate health threats. However, at some of the residential locations the hazards may be more immediate if children at those locations were to exhibit periodic pica-type behavior.

3. Based on ATSDR's public health conclusion categories, TDH has categorized this site as a public health hazard. The conclusions reached in this consultation are to a large extent based on conservative assumptions with respect to protecting public health. There are acknowledged uncertainties with respect to some of the issues surrounding exposure to these contaminants, particularly arsenic. Soil availability, individual habits, and bioavailability are all factors that could affect the true public health significance of the lead and arsenic in the soil.

PUBLIC HEALTH ACTION PLAN

Actions Planned

1. EPA plans to provide residents with the sampling results.

2. TDH/ATSDR plans to work with EPA to provide information to residents on how to limit their exposure to contaminated soil (for example, frequent hand-washing particularly for young children).

3. EPA plans to further characterize the soil in residential yards.

4. EPA plans to conduct a bioavailability study.

5. Once the data from the residential yards and the bioavailability study are available TDH and ATSDR will work with EPA to decide on appropriate public health actions.

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Table 1. Surface Soil Sample Results for Lead by Area Type, El Paso, Texas

Area Type	Number of Samples	Number of Locations	Avg. (mg/kg) (min-Max)	# Samples $ 500 mg/kg	# locations $ 500 mg/kg
Residential	223	128	244 (4 ! 1,600)	29	24
Daycare	41	28	89 (4 ! 920)	2	1
Apartments	14	10	144 (6 ! 530)	1	1
Churches	11	6	84 (6 ! 290)	0	0
Parks	10	6	190 (4 ! 190)	0	0
Schools	9	5	73 (6 ! 340)	0	0
Community Centers	7	5	63 (4 ! 20)	0	0
Playgrounds	3	3	40 (37 ! 43)	0	0

Table 2. Surface Soil Sample Results for Arsenic by Area Type, El Paso, Texas

Area Type	Number of Samples	Number of Locations	Avg. (mg/kg) (min-Max)	# Samples $ 20 mg/kg	# locations $ 20 mg/kg
Residential	223	128	19 (2 ! 490)	65	44
Daycare	41	28	7 (1 ! 40)	2	1
Apartments	14	10	15 (2 ! 58)	5	3
Churches	11	6	6 (1 ! 11)	0	0
Parks	10	6	8 (2 ! 27)	2	1
Schools	9	5	6 (2 ! 15)	0	0
Community Centers	7	5	3 (1 ! 4)	0	0
Playgrounds	3	3	7 (4 ! 9)	0	0

Table 3
Estimated Soil Concentrations Needed to Exceed the Acute LOAEL[1] for Serious Effects for Arsenic, Pica (5,000 mg soil per day).

Body Weight (Kg)	Soil Concentration (mg/kg)
15	150
20	200
25	250
30	300
35	400

[1] LOAEL for serious effects = 0.05 mg/kg/day [28]

Figure 1. Distribution of Lead in Surface Soil Samples, El Paso, Texas

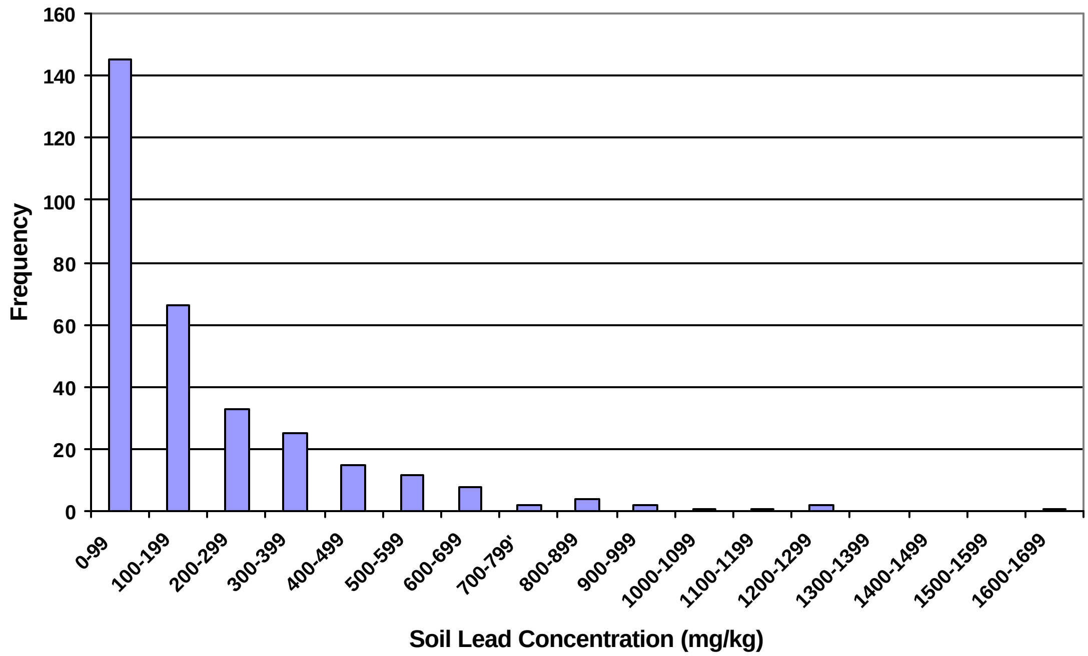
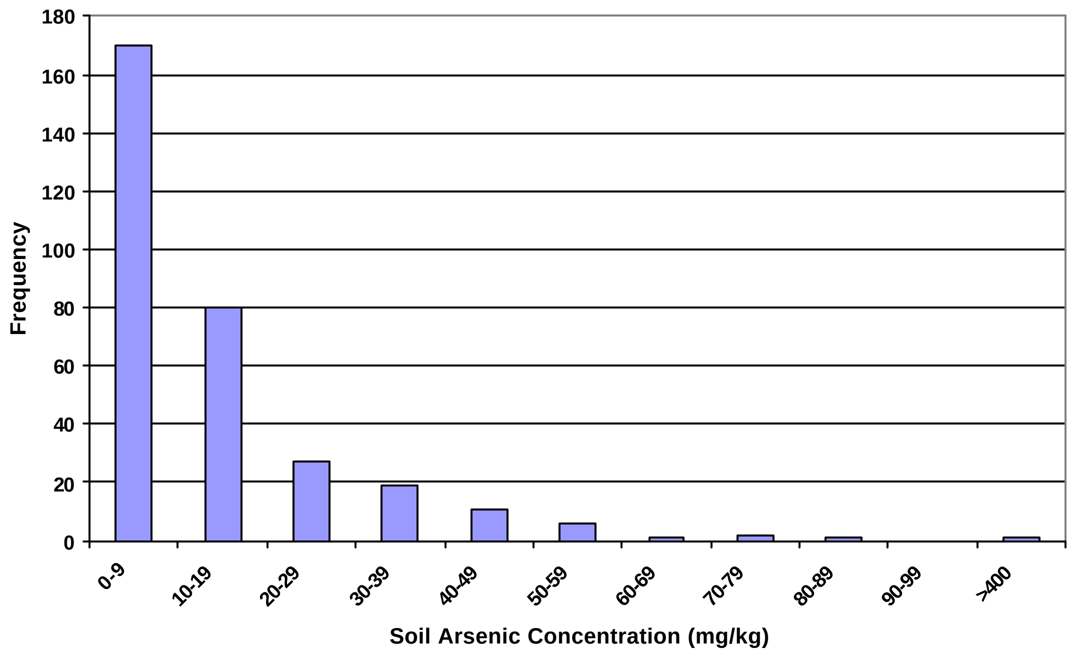


Figure 2. Distribution of Arsenic in Surface Soil Samples, El Paso, Texas



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CERTIFICATION

This health consultation was prepared by the Texas Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Chief, State Programs Section, SSAB, DHAC, ATSDR